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SPRAYING STRAWBERRIES FOR THE
CONTROL OF FRUIT ROTS.

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EXPERIMENTS FOR THE CONTROL OF STRAWBERRY ROTS.

Although the strawberry is more widely grown in the United States than any other fruit and is more perishable than any of the more important fruits, there is no region where spraying is generally practiced. Spraying for the control of the leaf-spot diseases has been frequently recommended, and a few growers in widely separated localities have sprayed regularly for fruit rots and have reported an apparent reduction in losses. So far as the writers have been able to learn, however, the first systematic experiments for the control of fruit rots of strawberries by spraying are those here briefly reported.

SCOPE AND IMPORTANCE OF THE PROBLEM.

The loss from decay of strawberry fruits, while difficult to estimate, is certainly very large. The census of 1920 gives the strawberry crop of the United States in 1919 as 176,931,550 quarts. At 20 cents per quart this crop would represent a value of over \$35,000,000.

¹ Mr. Stoddard during the course of this work was on leave of absence from the Connecticut Agricultural Experiment Station.

It is worth noting that the strawberry crop ranks fourth among fruit crops of the country, being exceeded only by apples, citrus fruits, and peaches. How much is lost by the decay of this fruit in the field can not be determined even approximately. Certainly an estimate of 5 per cent lost by rot would be very low. Under unfavorable weather conditions the loss often reaches half the crop. Careful observers in White County, Ark., which produces over \$1,000,000 worth of strawberries annually, place the loss for field rots there in 1922 and 1923 at not less than one-fourth of the crop each year.

The losses from decay in transit and on the market are even more serious, for while field rots result in a reduction of the crop, rot which occurs after the fruit leaves the field involves the expense of picking, packing, and freight charges on unsalable fruit, as well as the cost of claims and reconditioning. The losses from decay in transit are greatest, or at any rate most conspicuous, in the great strawberry-growing regions of the South, from which the fruit is shipped to cities of the North and West and to Canada. Car-lot shipments of strawberries in the United States in 1922 totaled 18,747, of which 3,592 cars originated in Tennessee, 2,190 in Arkansas, and 2,043 in Missouri. All of these States suffer heavily from rot in transit.

These facts were emphasized in the fall of 1922 by a call for help from the strawberry growers at Beebe, Ark. Consequently, the writers undertook, in the spring of 1923, after a thorough discussion of the problem with the pathologists of the Arkansas Agricultural Experiment Station, a series of experiments in spraying and dusting strawberries. This work was carried on during March, April, and May and had at all times the active assistance of the growers.

The results of the first year's tests are here summarized for the information of interested strawberry growers and the plant pathologists of the United States. The writers realize, of course, that the results of one year's experiments are necessarily inconclusive. They feel, however, that the results obtained, even though not entirely satisfactory, are worthy of publication for the following reasons: (1) They represent the first attempt so far as known to control strawberry fruit rots by spraying or dusting; (2) they were obtained in fields that showed an extremely high percentage of rot in 1922, probably more than that occurring in most of the fields near Beebe; (3) they were obtained during the wettest May recorded for Arkansas since 1907 and one of the five wettest since 1890; and (4) the information gained in these tests is urgently needed by strawberry growers in certain parts of the South as an indication of what relief from a really serious situation they can expect through spraying or dusting. But these results were obtained in only one locality, and the problem of strawberry fruit rots is an important one in a very large number of localities. The strawberry is grown commercially in practically every State as well as the Territories of Alaska and Hawaii. The fungi causing fruit rots of the strawberry are known to vary, at least as to species and their relative abundance, in different regions. For a single group to work out practicable spray schedules which will be generally applicable, or even to test the value of spraying in all these regions, is obviously impossible. It is

therefore earnestly hoped that pathologists in various parts of the United States will test the value of spraying and dusting as means of reducing the losses from the fruit rots of strawberries.

METHODS USED.

The strawberry fields chosen for the experiments were all in the vicinity of Beebe, Ark., and were known to have suffered heavy losses from rot during the previous year. The spray period extended from March 9, 1923, when the first buds were opening on the Klondike variety, to April 21, when the first berries were beginning to show pink. Bordeaux mixture (4-4-50) was applied with a horse-drawn power sprayer having fixed nozzles and giving a uniform pressure of 175 pounds at the gauge on the air chamber. This outfit sprayed five rows at a time. The dusts, (1) a copper-lime dust having 15 per cent dehydrated copper sulphate and 85 per cent lime and filler, and (2) a dusting sulphur having 93 per cent sulphur and 7 per cent filler, and known to be free from arsenic, were applied with a hand blower. Five applications were made, the dates being as follows: Spray, March 10, 15, and 26, and April 10, and 20; dust, March 12, 17, and 27, and April 7 and 20. A few of the plats received all five applications; others received a smaller number, down to only one. One or more check plats were kept in all experimental fields.

The first fruit was picked on May 5. During the interval between the last treatment and the first picking rain fell on nine days, the total rainfall for the two weeks being 5.57 inches. These conditions, of course, made the control of rot-producing fungi more difficult, as all visible traces of the spray or dust materials had disappeared several days before even the first fruit was picked.

In order to learn the effect of the various treatments, tests were made in duplicate of the keeping quality of fruit from the experimental plats. In each test a set of boxes of fruit was held at a temperature of 40° to 45° F., at Beebe, and a corresponding set shipped (in a small "pony" refrigerator of the type used by Florida strawberry growers) to Buzzards Bay, Mass.; New Haven, Conn.; or Chicago, Ill. At the end of four days in the holding tests and as soon as possible after arrival in the shipping tests, the berries were carefully hand sorted and counted. In these keeping tests 768 quarts of berries from 30 sprayed, dusted, and check plats were sorted and counted.

RESULTS OBTAINED.

The work was undertaken with a full appreciation of the difficulty of properly spraying a fruit like the strawberry, which not only bears the berries close to and often resting upon the ground but matures its crop over a period of several weeks and often has ripe berries and unopened flower buds at the same time. It was realized that these conditions might make impossible such complete control of diseases as is obtained with apples and grapes. For this reason and because of the difficulty of getting the rotten fruit properly picked and measured, attention was directed to the keeping quality of the fruit which appeared sound when picked. Incomplete data which were obtained on the loss from rot in the field at picking time

are to be reported in another paper. Suffice it to say that this loss at times amounted to 50 and even 75 per cent of the fruit that was ripe enough for marketing and for the whole season to about 25 per cent of the crop. Organisms causing the rots were undetermined species of *Phytophthora*, *Rhizoctonia*, *Pezizella*, and *Botrytis*, named in the order of their importance as rot producers. The apparent effect of the different treatments on the keeping quality of the fruit is given in Table 1.

TABLE 1.—*Effect of spraying and of dusting on the keeping quality of strawberries at Beebe, Ark., in 1923.*

Variety, plat, and treatment.	Percentage sound—	
	Holding tests, four days after picking.	Shipping tests, on arrival at destination.
Klondike on Thornton plats:		
Spray.....	75	58
Copper dust.....	74	52
Check.....	63	48
Klondike on Abington plats:		
Spray.....	81	69
Copper dust.....	77	52
Check.....	71	67
Aroma on Thornton plats:		
Spray.....	60	45
Copper dust.....	45	38
Sulphur dust.....	59	40
Check.....	39	40

In Table 1 the results of all the various spray and dust schedules are averaged. This is done because of the fact that no one schedule showed a clear superiority over the others, indicating that no really satisfactory spray schedule has been worked out. The writers feel, however, that the results justify the conclusion that spraying with Bordeaux mixture, and in some cases dusting, reduced the loss from rot which developed on the fruit after it was picked sufficiently to more than justify the expense of the treatment.

The work has not progressed to a point where a spray schedule can be confidently recommended as satisfactory, nor is spraying yet to be advised as a general commercial practice. Strawberries are grown in the United States under a great variety of conditions, and spray schedules must necessarily be varied accordingly. For example, in no case should strawberries be sprayed so near picking time that under the probable weather conditions for the locality there is danger of undesirable spray residue remaining on the fruit at picking time.

The results of the first season's work seem, however, to indicate that in the region where this work was done strawberry rots may be reduced by spraying. It is accordingly planned to extend these spraying tests.

